MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

SUPPLEMENTARY EXAMINATION

TRIMESTER 1, 2015 / 2016

PPH0135 - ELECTRICITY AND MAGNETISM
(Foundation in Engineering)

18 NOV 2015
9.00 AM – 11.00 AM
(2 HOURS)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **FIVE (5)** printed pages excluding the cover page and appendices, with **FOUR (4)** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 (15 marks)

a) **Figure Q1.1** shows a strip of silver with dimensions of 50.0 mm x 20.0 mm x 500.0μm, is placed in a magnetic field ($B = 0.5$ T) directed perpendicular to the plane of the silver strip. A current $I = 12$ A is sent down the strip as shown in the figure. If the electron density of silver is 5.86×10^{28} per m^3, determine

i. the drift velocity of electrons.

(2 marks)

ii. the magnitude and direction of the electric field in the strip.

(2 marks)

iii. the reading of the voltmeter V.

(1 mark)

iv. which side of the voltmeter is at the lower potential.

(1 mark)

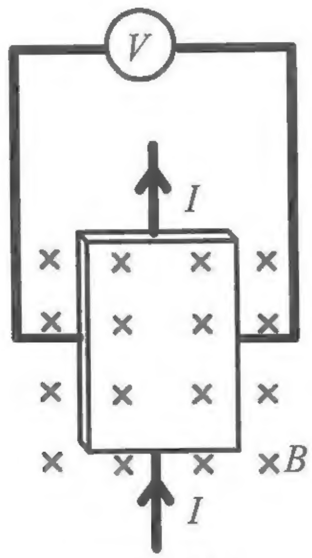

Figure Q1.1

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b) **Figure Q1.2** shows an electron moves in a circle of radius R in a uniform magnetic field B, directed out of the page.

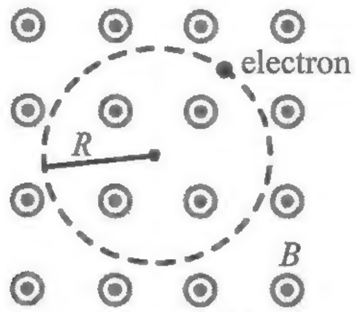

Figure Q1.2

i. Does the electron move clockwise or counter clockwise?

(1 mark)

ii. Derive an expression for the time taken for the electron to make one complete revolution.

(3 marks)

iii. If $B = 0.2$ T, determine the value in part (ii).

(1 mark)

c) **Figure Q1.3** shows two conducting loops placed in the same plane. If switch S is closed,

i. what is the direction of current flowing in loop 2? Explain.

(3 marks)

ii. does the the current in loop 2 flow for only a short moment , or does it continue?

(1 mark)

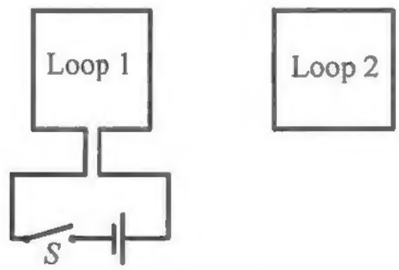

Figure Q1.3

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QUESTION 2 (15 marks)

a) A battery is connected to a resistive load that has a resistance of 20.0 Ω. A voltmeter across the battery reads 7.8 V when the load is in place and 9.0 V when the load is removed. Determine the internal resistance of the battery.

(3 marks)

b) Two tungsten wires, one with a diameter double of the other, have the same current flowing through them. If the drift speed of the thicker wire is v_1, and the drift speed of the thinner wire is v_2, calculate the ratio of the drift speeds.

(3 marks)

c) Four identical resistors are connected to a battery as shown in **Figure Q2.1**. When switch S is open, the current through the battery is I_o. Calculate the current flows through the battery when the switch is closed. Give your answer in terms of I_o.

(3 marks)

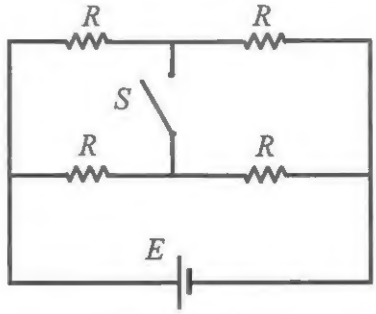

Figure Q2.1

d) Use Thevenin's theorem to find current through and voltage across R_1 in **Figure Q2.2**. Provide Thevenin equivalent circuit in your answer.

(6 marks)

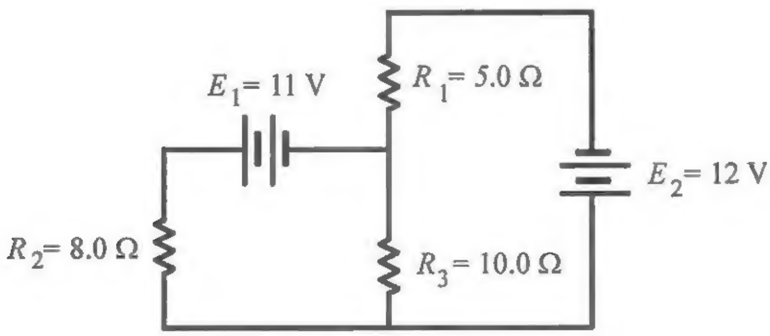

Figure Q2.2

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QUESTION 3 (10 marks)

Figure Q3 shows a series RC circuit. The rms voltages across the resistor and the capacitor are the same.

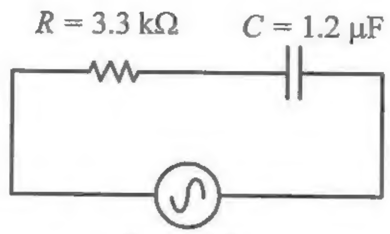

Figure Q3

a) What is the frequency of the source?

(2 marks)

b) Write the rms voltages across the resistor and the capacitor in terms of the rms voltage of the source.

(2 marks)

c) What is the impedance of the circuit?

(2 marks)

d) What is the phase angle between the source voltage and current? Which leads?

(2 marks)

e) Draw a phasor diagram for the circuit.

(2 marks)

QUESTION 4 (10 marks)

a) **Figure Q4.1** shows a diagram of unbiased *pn* junction in equilibrium. The shaded area represents depletion region.

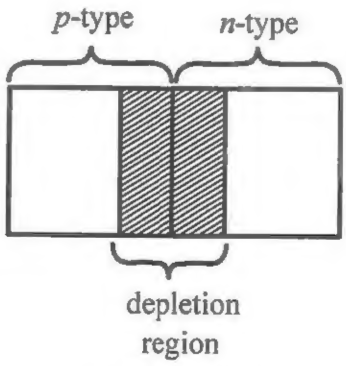

Figure Q4.1

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i. What is the net charge of the *pn* junction?

(1 mark)

ii. What is the net charge of the *p*-type?

(1 mark)

iii. What is the net charge of the *n*- type?

(1 mark)

iv. Does a *pn* junction have a capacitance behavior associated to it? Explain.

(2 marks)

a) Find the magnitude of I_B, I_E and I_C in **Figure Q4.2**, given that $\alpha_{dc} = 0.98$. Assume that the transistor is of germanium (Ge) type.

(5 marks)

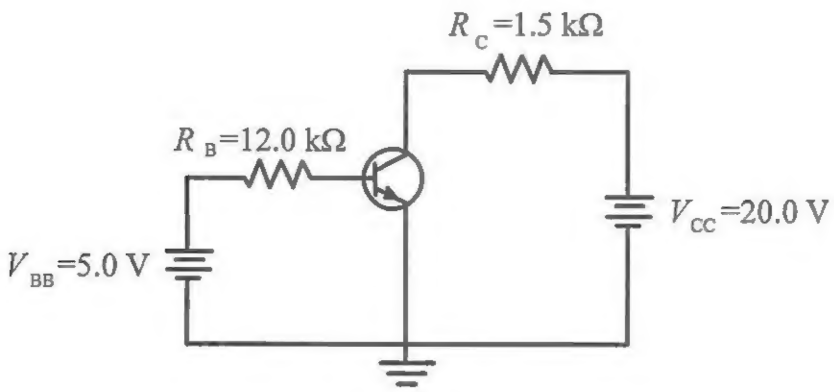

Figure Q4.2

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APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m/s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W/m^2
Coulomb constant	k	8.988×10^9 N m^2/C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

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APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 n I$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right) I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$P_t = I_{rms} V_{rms}\cos\phi$$

$$P_r = V_{rms} I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0[1 + \alpha(T - T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right) V_S$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_0 I}{4\pi}\frac{d\ell \times \hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

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